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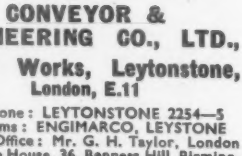

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FOUNDRY TRADE JOURNAL
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## Some Post-War Problems

Our policy from time to time in directing attention to post-war conditions is occasionally criticised as being likely to detract from the war effort. Yet we are reasonably sure that if the Press of the United Nations had given the attention it warranted to preparation for hostilities in the decade 1929-1939, there would have been no war at the present time, and it might have been postponed indefinitely. By devoting a reasonable percentage of one's thought-output to post-war conditions, a campaign can be inaugurated which will ensure that the transition will be made in such a manner as to cause a minimum amount of distress. All free nations are planning with this object in view. The South African Press is carrying appeals for "Place Your Post-war Orders Now" and typifies the general approach to the problem. Because of the magnitude of the task, much attention in this country is being given to "rebuilding Britain," and a new Ministry—the Ministry of Works and Planning—has been created with the object of ensuring a good start in the immediate post-war era. We prophesy for this department a particularly rough passage, as the contrary winds of idealism and practical urgency will create stormy seas. The idealists are insistent on the dual aspect of the clearing away of slums and the preservation of the amenities of the countryside. These are to be effected by town and rural planning through the creation of new building regulations and Acts of Parliament dealing with the wider aspects. Practical urgency demands the immediate repair of every war-damaged dwelling house and the construction of thousands of new ones, in order that the returning soldiers, mobile munition workers and evacuees may have a roof over their heads. The problem is being complicated by proprietary interests in land tenure, shortages of materials and labour, and the campaigns of the idealists. Naturally enough, these few factors cited, amongst many others, embarrass those whose job it is to plan for that section of the foundry industry which caters for the building industry. In the past the arbiters of design have been the customers, the civic councils, the gas and electricity concerns and the jobbing builder, because they placed their orders according to what they deemed to meet their requirements. Now some foundry concerns are being accused of meeting competition in fuel-burning apparatus by cutting down excessively the section of the castings they incorporated. This, it should be remarked, in a trade where castings are not sold by weight! There seems to be still little appreciation of the fact that thin-walled iron castings are less prone to growth on repeated heatings and are relatively stronger. There are suggestions afoot that either specifications or standard codes should be prepared for all the various entities which go to the make-up of a building. For foundry products there seems to be a ready-made solution, for an exact parallel will be found in the past work of the B.I.A. All the materials which could be scheduled on an agreed price-list can be the subject of rational standardisation; for those goods which are based on patents, trade marks and registered design no such action is possible without impairing speed of production and, on a long-term policy, technical progress. Even designing within a Code of Practice may be of limiting character. However, the creation of dimensional ranges and minimum thermal efficiencies may have beneficial repercussions. The main factor to be feared is that the demand for accommodation may be well ahead of the legislation necessary to ensure compliance with all the new regulations envisaged. No matter what steps are taken, we do not think that preferences for either pre-last-war or pre-this-war houses will be based on the material furnished by the foundry industry, as the newer products supplied are in nearly every case infinitely superior.

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# INSTITUTE OF BRITISH FOUNDRYMEN

## FALKIRK ANNUAL GENERAL MEETING AND QUESTION NIGHT

The final meeting of the present series was held in the Temperance Café, Lint Riggs, Falkirk, on March 26. The retiring President, Mr. Geo. C. Wilson, presided over a very satisfactory attendance of members and visitors. The meeting combined the annual general meeting and a question night. The following officers were elected:—As President, Mr. John S. Kidd; as Vice-Presidents, Mr. R. R. Taylor and Mr. T. R. Goowin; as Committeemen, Mr. A. D. Wilson, Mr. J. A. McIntosh, Mr. W. W. Blair, Mr. J. Hobkirk, Mr. E. Cunningham, Mr. Wm. Montgomery, Mr. Wm. Paterson, Mr. T. Moodie, and Mr. J. N. Reid; and as Hon. Secretary, Mr. T. R. Goodwin.

The question night then followed, and the first question was posed by MR. ROBT. R. SHAW, of Larbert, who asked, "At what price would ironfounders need to buy current, in order to make the electric furnace as economical as the cupola for the melting of cast iron?" This question developed a lengthy discussion which was more relative to the merits and demerits of the method than the cost. Mr. Shaw quoted the Institute's 1st Report on "Melting Furnaces for Cast Iron," which gave typical melting costs, using various types of furnace. Bearing in mind such schemes as the hydro-electric power scheme, he thought that if power could be supplied at 0.1d. per unit, the electric furnace would be as economical as the cupola.

### Flexibility of Cupola

Mr. Wm. Montgomery (Leven) thought that the flexibility of operation of the cupola always would prevent the general adoption of the electric furnace as a melting unit for cast iron, irrespective of the cost of power. Mr. Shaw suggested the use of two or more furnaces to overcome this. Mr. A. D. Wilson thought that the great subsidiary consumption of power in connection with melting in electric furnaces would raise the cost a great deal. Mr. R. R. Taylor (Larbert) said that in America, more development in melting technique was taking place along the line of the cupola than that of the electric furnace. Likewise, cupola melted iron was superior to that melted in the electric furnace. Further, the use of steel scrap in the electric furnace was not very efficient, hematite being more suitable. Mr. J. A. Donaldson (Carron) thought that there was little likelihood of the cupola being ousted by the electric furnace, but he considered that the latter could be very handy, if a material of composition similar to the transition stage between steel and malleable iron could be used, without recourse to annealing. Mr. W. W. Blair (Camelon) pointed out that the most acute aspect would lie in the question of supply, should the whole of Falkirk district take to melting in electric furnaces.

MR. W. W. BLAIR then asked, "Would it ever be possible, or feasible, to maintain the cupola alight overnight?" Mr. Tyrie, of the B.C.I.R.A., said that experiments had shown how a period of two hours was the maximum at which the cupola could satisfactorily be held without tapping. Mr. Blair believed that the question of slag was the governing factor in this question. Several members spoke on the aspect of lining erosion; this took place, according to Mr. Blair, because of the severe heating then equally severe cooling, which came of normal cupola practice. Mr. Tyrie said that any advantage in retaining the cupola overnight would be entirely dependent on whether coke consumption over that period was less than the normal cost of making up each day.

### Mixing in the Cupola

The third question came from MR. A. D. WILSON (Falkirk), who asked, "Does steel scrap mix thoroughly in the cupola?" Mr. Wilson explained how certain castings showed greater hardness in the heavier sections than in the light when being machined. Mr. Wm. Montgomery was of the opinion that there had been improper mixing in the cupola, while Mr. R. R. Taylor said that slight porosity in the heavy sections would tend to give the appearance of harder metal there. Mr. Tyrie quoted cases where a higher combined carbon had been found in a heavy section than in the lighter sections of a casting, due to variation in the thickness of sand surrounding a casting. This caused variations in the rate of cooling, and therefore in the state of the carbon.

MR. WM. MONTGOMERY asked whether any member had read of the "Ultra-Sonax" system of testing molten metal. He believed that this method of using sound waves was being developed in the U.S.A. No one present, however, could give any further information on the subject.

MR. T. TYRIE, B.Sc., produced a fluted grinding plate made in white iron, and asked if any of the members could advance an explanation, as to why the tops of the flutings were quite easily machineable, in spite of the nature of the material in which they were made. Mr. R. R. Taylor suggested that the fins were cooling quickly, due to their section, then being annealed by the transfer of heat from the main body of the casting. This was considered a feasible explanation.

MR. J. A. DONALDSON'S question was as follows:—"What will be the influence of plastics on post-war ironfounding practice?" The main idea on the subject was that there need be no fear of a general replacement of cast iron by plastics, as it had been stated recently that it took 100 tons of coal to produce 100 lbs. of the powder necessary in the manufacture of plastics. Mr. Taylor was of the opinion that for fine engineering applications plastics were not adaptable. Mr. Donaldson quoted how the possibility of synthesising plastics would make their production much more economical, but the general feeling was that, although in several fields competition might be expected from plastics, the ironfounding industry would still be prominent in post-war years.

The meeting closed with votes of thanks to the President and Secretary for their work during the session.

# THE GATING OF CASTINGS*

By E. W. HARDING

*Slow-Motion Cine Studies of Running Conditions Reveal Optimum Gating Practice*

It is not proposed to cover the whole field of running and risering of castings as they are really two separate and distinct topics. Instead, the Paper will be confined almost entirely to the subject of gating. References to risering practice will be merely incidental and in relation to its influence on gating procedure. Furthermore, in dealing with gating, stress will be laid upon the close relation existing between the standard of gating practice and the level of foundry defectives. Any means of reducing these defectives is of direct and pressing interest at any time, but during the present period it is a vital matter in relation to the conservation of labour and materials and therefore ultimately to the successful prosecution of the war. The importance of gating is actually two-fold: Firstly, in respect of casting quality—in its influence on the cleanliness and soundness of the casting, and, secondly, in regard to cost and efficiency —in its direct and close relation to losses on defective castings. Both are clearly essential factors. Thus gating directly affects the primary objective of the foundry; namely, profitable and efficient production of good castings.

The effect of gating practice on defectives has been convincingly demonstrated over a number of years by means of accurate defectives records. These records take the form of classified lists of defects and it is the duty of the castings inspector to compile the list of defectives, classified by nature of defect, for each day's production. A weekly scrap analysis sheet is made from these daily records and this is the basis on which causes of defects are determined and corrective action applied.

Experience obtained in this way for many foundries has shown that by far the greatest single cause of defectives can be classified under the heading of "incorrect gating," mainly resulting in sand and slag defects. The average proportion due to this cause has been found to range between 30 and 50 per cent. of the total defectives. Now, if one takes the normal average loss on defectives, reported by many iron-foundries, as lying between 5 and 8 per cent. of the total casting production, the astonishing fact comes to light that on a conservative estimate this loss amounts to between 75,000 and 100,000 tons of castings per year. It should not be necessary to emphasise the importance of such a loss in labour, fuel and supplies, particularly at the present time. If many of the points brought up in regard to good gating practice appear to be obvious, justification must lie in the fact that they are overlooked in practical operation, as evidenced by the results obtained.

* A Paper illustrated by lantern slides and moving pictures before meetings of the London and East Midland Branches of the Institute of British Foundrymen. The author is on the metallurgical staff of the International Mechanite Metal Company, Limited.

In any attempt to reduce defective castings it is essential to search for basic causes rather than try to give individual treatment to each defective piece. This is where the analysis of defects serves a useful purpose, in indicating the operating conditions (*e.g.*, sand, gating, metal, equipment, etc.) responsible for the bulk of the defects. That is to say, the record of defectives gives the *types* of defects encountered on the various jobs, and the summary and analysis of these defects for the whole production provide the key to the *causes* of defects. Defects due to incorrect gating consist mainly of:—

*Defect.*—Sand and slag inclusions.
*Cause.*—Lack of efficient sand and slag traps; loose sand or sharp edges in gating system; dirty or badly made pouring basin; and no choke at ingate.
*Defect.*—Misrun and coldshut.
*Cause.*—Incorrect gate distribution; slow pouring rate; and poor basin design.
*Defect.*—Shrinkage.
*Cause.*—Incorrect position of gate in relation to riser, *e.g.*, ingate to shrink bob.
*Defect.*—Mould or core scab.
*Cause.*—Excessive mould or core surface erosion by badly placed gates.
*Defect.*—Distortion.
*Cause.*—Incorrect gate distribution.

### Correction of Defects

In the correction of gating defects, certain fundamental principles must be recognised and it is by the application of these principles that efficient practice is obtained. It is not intended to imply that there is only one correct way of gating any casting. There may, in fact, be many ways of running a casting to get equally satisfactory results from the quality point of view; though there may be considerable differences in the costs for the various methods. The point, however, is that only those ways conforming to sound principles can be effective in the long run. Before going on to consider practical examples, these principles will be discussed briefly. It will be understood that particular reference is made throughout to iron-foundry practice, though naturally the principles involved apply to other materials.

The function of the gate is obviously to introduce molten metal into the mould, but certain conditions must be fulfilled in the operation. These are principally:—(1) Efficient sand and slag trapping; (2) correct heat distribution; (3) minimum mould surface erosion. and (4) suitable rate of pouring.

### Sand and Slag Trapping

This is probably the most important of the above conditions in relation to defective castings. For this reason, great stress is laid on this feature of the

## The Gating of Castings

gating system and methods for preventing entry of foreign matter into the mould will be shown in some detail.

The principles involved in sand and slag elimination are:—(*a*) The difference in density of metal and sand—permitting of separation by flotation in pouring basin, runner bar, whirl gate, etc., and (*b*) the relative viscosities of molten metal and slag—the lower viscosity of hot metal permitting it to pass through openings which retain liquid slag. This is utilised mainly in strainer core practice.

These principles have been translated into practice by the development of a large variety of gating systems, all of which fall into two fundamental divisions—those in which the dirt is floated out and those in which it is strained out. Many modifications and combinations of gates have been tried out, but the systems mainly employed for slag-trapping are:—(1) Cope runner bar with drag ingates; (2) cope projection gates; (3) flow-by gate; (4) syphon skim gate; (5) whirl gate, and (6) strainer core.

### Correct Heat Distribution

The ideal condition is as nearly as possible a uniform temperature in all sections of the casting during solidification. This serves to minimise warping and internal stresses, and gives best conditions for a uniform structure in all sections. For any given casting design, locating metal entry to suit the various sections is the chief means to this end.

In cases where metal sections are so varied that feeding of the heavier section is normally necessary for soundness, two systems of metal entry are available:—

(1) Gating into the lighter section, so that the heavy section receives the colder metal—thus balancing the natural temperature gradient due to varied cooling rates. By this method, feeding of the heavy section may often be eliminated since practically simultaneous setting occurs. The method is naturally limited in application to certain designs and sections, but in experienced hands yields efficient results. This method also makes for good machinability in the light sections.

(2) Gating into the heavier section, which is then rendered sound by feeding. This is the method normally recommended where sections are too heavy to respond to the first system. In its most efficient development it follows the principles of progressive, directional solidification, and takes the practical form of gating into the riser. By regulating the pouring speed it is possible by this system to reduce feeding to the minimum; for example, in casting a gear blank with heavy rim and hub, gating into a riser on the hub, with hot metal and slow pouring, can yield a sound rim without risers.

A knowledge of gating implies the ability to reason out what will happen when the metal is introduced into the mould in a certain way. A useful picture can be obtained by drawing isothermal lines to represent the heat gradients during solidification. By this means it is possible to avoid incorrect practice and see more clearly the most suitable points of metal entry, the parts to be fed and, in general, the system of gates best suited to the particular type and design of casting.

### Mould Surface Erosion

The importance of locating and designing gates to minimise sand erosion during pouring is obvious but frequently overlooked. Points requiring consideration here are velocity of molten metal at various points in the gating system, relation between height of fall and velocity, impingement on exposed and unsupported surfaces, sharp edges of sand in gate and mould, etc. Account must be taken of the fact that one is asking a rather fragile object, made of sand and clay, to withstand the weight and rush of molten metal, often travelling at high velocity and frequently at temperatures approaching the fusion point of the sand itself. Even under best conditions the factor of safety is relatively low and the high proportion of defects traceable to gating indicates that even this low safety factor is rarely obtained.

The question of top or bottom pouring frequently comes up for discussion and is influenced by this matter of mould erosion. Like many gating decisions, it is largely a matter of compromise between a number of factors, some of which are opposed to one another in the method required. Top or joint gating is ordinarily to be preferred, mainly on metallurgical grounds, since it favours correct thermal lines and renders more accessible the parts to be fed. However, sand erosion from either mould or core is accentuated with top pouring and special precautions in gate location and mould material and condition must be taken in these circumstances.

Points needing particular attention in regard to sand erosion are:—

(1) Avoid sharp corners and edges in gating system.

(2) Avoid locating ingates so that metal strikes directly against a core or sharp corner or fragile part of the mould.

(3) Avoid running metal on to a surface from which it is drained as the metal drops to a lower level in the mould.

(4) Avoid constriction of ingates at casting—a nozzle effect is thereby produced, with high metal velocity. A slight flare of the ingate at the casting is recommended to reduce velocity.

### Pouring Speed

This is determined by the total ingate area and the head of metal from basin to ingate. It is naturally a vital factor in avoiding misruns and obtaining soundness and cleanliness. Generally, the lower the fluidity of the metal used, the faster must be the pouring speed for sound and clean castings.

The nature and design of the work being poured, however, is the main factor in the rate of pour, and no hard-and-fast rule can be laid down to cover all cases. Experience over a large variety of castings in many different foundries has shown an approxi-

mate relation to exist between satisfactory pouring speed and casting weight. By plotting pouring rate in tons per minute against casting weight in tons, it is seen that the rate of pour increases rapidly with increase in casting weight. The range is wide, varying from some 10 tons per min. for heavy castings to about one-tenth of a ton per minute for light castings. Practical experience and judgment are normally depended upon to control this variable, but some measure of correction by applying known standards would do much to restrict variation due to this factor. Other conditions besides casting weight naturally influence rate of pour (casting design, presence of cores, flat top surfaces, metal fluidity, etc.). These should be included in any tabulation of standard rates of pour, which would apply, of course, specifically to the particular foundry's practice and conditions.

### Choking the Gate

One of the most important facts to bear in mind is that, no matter how well a runner bar is designed or located, unless the total ingate area bears a correct relation to that of the other parts of the gating system, then it will be inefficient and may be directly responsible for defective work. This follows from the principles governing efficient slag trapping, particularly trapping by flotation. Sufficient reserve of metal must be available, right from start of the pour, to keep the slag-trap full. In other words, the gate must be choked. This is very obvious and elementary, but how often overlooked.

The particular arrangements employed for preventing entry of slag will naturally influence the degree of choking, but a safe mean range lies within 20 to 40 per cent. of the downgate area. This assumes, of course, that the basin is kept full and that the only restriction to metal flow is the area of the various members of the gating system. Strainer core work is naturally a different matter. Here choking takes place between the downgate and the strainer core and, provided that the core is not located too far from the casting, the area of ingate is not a material factor in obtaining clean castings.

### The Pouring Basin

No gating system can be efficient that neglects the design and condition of the pouring basin. The basin is an essential part of the system. Its main functions are:—(1) To allow time for separation and flotation of sand and slag before metal descends to the downgate; and (2) to permit quiet entry of iron into the downgate at constant velocity—that is, avoiding whirlpooling at basin outlet. Both of these objects are attained through correct basin design and dimensions. A further condition is that the basin must be properly made (preferably by pattern), so that loose sand and sharp edges are absent and that sand erosion during the pour is at a minimum. Poor basin design and condition is undoubtedly one of the principal causes of dirty castings, and the conclusion is that, however simple and obvious may be the principles underlying basin construction, the matter is neglected in practice.

### Film Illustrating Gating Methods

A few words of explanation are advisable so that the film shown by way of illustration will be understood without difficulty. This film has been produced by an American Meehanite licensee (Greenlee Foundry Company) in order to interest their staff in the subject of gating, and so to control what was to them the biggest source of loss on defectives.

It will be appreciated that the difficulties in making such a film are considerable. Lighting conditions in a foundry are bad, owing to low reflective power of black sand. In order to show the metal running through the gates and into the mould, special arrangements had to be made for removing the top part of the mould. To give enough time to see clearly how the metal behaves, it was necessary in some cases to reduce speeds by slow motion.

The first part of the film shown represented preliminary efforts in developing the technique necessary to demonstrate metal flow in the mould. This part dealt with a mould containing a heating element which was to be cast-in. Then followed shots showing dry sand moulds poured through the riser, where the slag retained on the surface could be seen; and also the pouring of bushing castings from a common basin and central runner. These were merely shots to show what a film study of this nature would demonstrate. These were followed by scenes of gating a mould for a simple flat plate casting, with four different arrangements of the same runner bar and ingates. The remainder of Part I dealt with six different ways of gating a gear pattern and the way the metal behaved in such a mould.

Part II of the film showed five different series of gating systems, demonstrating:—(1) The effect of three positions of the ingates to a whirl gate and runner bar. (2) How to obtain a quiet flow of metal into a mould having a raised bead and thus forming a barrier to metal flow. Three different ways were shown. (3) The paths of metal flow into a flat plate poured "two-up"—gated first into the ends of the plate and secondly into the sides. (4) The difference in the amount of gas produced in a hard oil-sand core not vented; and in a soft core well vented. (5) Gating a bushing 16 in. long by 8 in. dia. in three different ways to see which method produced the least scum from sand erosion by metal flow.

It was pointed out that these films could only touch on the fringe of this vast subject. They were, in fact, intended mainly to provide a new approach to the subject to start thought on the many questions involved, and give a clearer insight into what happens when molten metal is poured into the mould.

The author expressed his indebtedness to the Meehanite Research Institute for permission to show the film and for the facilities accorded him in the preparation of these notes.

## DISCUSSION AT LEICESTER

MR. H. J. BECK, after complimenting the author on the excellence of his Paper and the films, asked what would Mr. Harding consider to be the correct

## The Gating of Castings

diameter to keep the strainer core going with seven holes ¼ in. in diameter and ½ in. thick.

MR. HARDING, in reply, said it would be quite easy to calculate. The point was the system needed a slightly decreased area of filter, but in this strainer core practice the question often arose whether it was better to have a large number of small holes or a small number of large holes. If there were a large number of small holes there was a much bigger resistance to metal flow for the same area, and therefore total area in this case should be higher.

MR. C. A. PAYNE asked whether in the case of large dry-sand or green-sand moulds, with what depth of runner was it necessary to step the downrunner? Was it advisable to choke the metal in the downsprue, making the metal wash over a step, and would it be necessary to make the step by means of a core? Although one had a large runner basin, with efficient slag trap, it would still be necessary to employ some form of choke in the runner.

The AUTHOR said that in most cases where there was such a height, a step was advisable; normally it would be a dry sand mould, in which case it would resist the wash of metal. Any sand washed from the gate would presumably be trapped in the runner bar which should follow that step. Undoubtedly there was a need for some form of choke with any runner system. Many people thought that by pouring a dry sand mould with a clean pouring basin, there was no necessity for any system of holding back dirt. He had seen very clean dry sand moulds poured with very clean metal and had found slag in the trap, *e.g.*, in the syphon gate. The dirt might come from the ladle or mould, and one must legislate for the worst conditions. One could not afford to waste a casting on the assumption that there was no dirt present.

MR. F. DUNLEAVY asked the author to amplify the point that the one aim behind the design of runners and ingates was to compel the metal to follow the contour of the mould and cores, if possible without disturbance. Dross would enter the runner box, and more dross or scum would be picked up as the metal proceeds through the down-runner into a dirt trap, and providing the design of the dirt trap and the dimensions of the down-runner and ingates, and their correct position had been ascertained, running troubles to a very large extent would be eliminated. Unfortunately, some of the larger sized castings of a jobbing nature must be made in existing box parts that very often did not lend themselves to this method of running, suggested by Mr. Harding, and in relation to these larger and intricate castings it was quite a different problem, from that of the simple type of castings dealt with.

He assumed that these examples had been selected by the lecturer to emphasise a principle that appeared to be largely overlooked by many people. Actually, the practice of casting an open sand mould was the practice of the old jobbing founder. Another point requiring clarification was that no dimensions were given of the runner basin, and presumably the addition of a plug or stop might be an advantage, thus preventing any slag or dross from the ladle finding its way down the runner, instead of trusting to the runner bar trapping this dross. He felt sure that if certain of these photographs were published, Mr. Harding's company would be doing a very fine service to the whole foundry industry.

### Danger from Plugged Pouring Basins

MR. HARDING said that the standard of inspection of a small casting was generally much more severe than that of a large casting. It must be remembered, however, that the same principles applied whether the castings were large or small. Advantage was taken of the fact that sand and slag separate by flotation. With a dry sand mould there was less danger of sand wash than with green sand, but this did not mean that one could afford to omit a dirt trap from a dry sand mould. It was a safeguard, and one should not take a chance. Many people used plugs in the pouring basin. There was, however, one danger, if the seating was not good it would do more harm than good, owing to the first metal trickling into the mould causing chilled drops before the main stream was released.

### A Wide Application

MR. R. D. LAWRIE said he could testify to the efficiency of the methods taught by the Meehanite Corporation, and so lucidly presented by the lecturer, as he had been in the fortunate position of being employed for some years by a firm who were Meehanite licensees, and who made castings weighing from a few ounces up to 40 tons. He assured the members present that the fundamental principles put forward this evening were applicable through all the range of castings mentioned, and in fact he had supervised the manufacture of castings up to 150 tons in weight, and so was in a very good position to judge of the efficiency of these methods.

Mr. Lawrie further stated that he had cast hydraulic cylinders up to 30 tons in weight top poured by the methods which they had seen on the screen, and which took into consideration the fact that the top was the last to solidify, so that he was satisfied that the fundamentals applied to these large castings as well as to the smaller ones. In conclusion, Mr. Lawrie thanked the lecturer, and said how much he had appreciated the lecture and illustrations.

MR. HARDING said he had seen the actual mould of the hydraulic cylinder. It was, he thought, about 30 ft. long, and was certainly a very good casting.

### Running a Circular Casting

MR. J. F. MEASURES asked Mr. Harding to express an opinion as to the best way to run a casting weighing about 1 cwt. It was a circular casting and of the type shown in Fig. 1.

In reply, MR. HARDING said it would be advantageous if the mould could be gated, using a riser over the hub. By fitting a strainer core in the runner bush over the riser, the entry of sand or slag into the casting could be prevented, as shown in Fig. 1.

MR. E. HOLLAND said he had always understood that horn runners were the least turbulent form of running, yet the film demonstrated the point that metal spurted into the centre boss of the wheel casting. If a casting of the type shown by Mr. Measures was run with a horn runner in the same way, would not the weight of metal in the boss tend to hold back the incoming metal and prevent this turbulence or spurting.

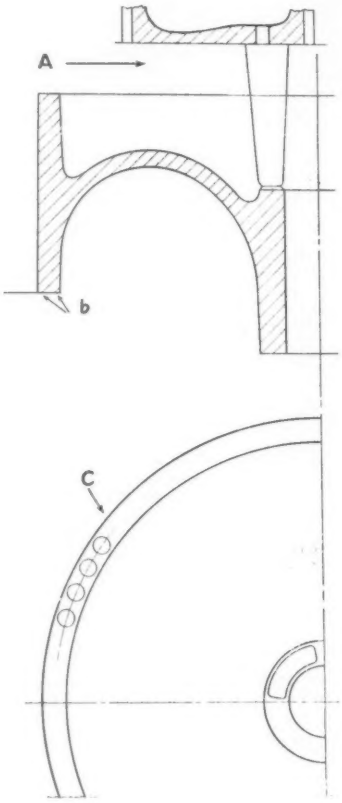


FIG. 1

Preferable method shown at A, with gate into riser over hub; to avoid entry of dirt, use tin skim or strainer core in basin. There is a tendency to chill at *b* and brittleness at this point with this method. Alternative method is shown in C, with four ½-in. pencil gates on rim; this is less satisfactory for uniform metal temperature across casting, but has the advantage of avoiding chilling on bottom edge of outside rim.

### Horn Gates

MR. HARDING said one must be sure with a horn runner that the mould was quite clean, and this was a difficulty. Drawing the runner pattern was likely to leave loose sand in the mould. Another factor was that the horn runner had a low opening area, and the metal entering through that opening must have a high velocity. In the case of a flat job, one did get a tendency to sand wash. He invariably preferred the flat runner because of the tendency to get sand in the mould. However, for some circular work, gating into the hub with the horn-gate was sometimes an advantage.

MR. R. F. ORME thought one had to alter tactics for different moulds. When dealing with a turbine casting of 30 tons weight, he preferred in such a case to start top running. He appreciated the speed of running and everything Mr. Harding had said for top running, but it did not invariably save striking of the sand at the bottom of the mould.

### Marine Turbines

MR. LAWRIE said that Mr. Orme's remarks on marine turbines were obviously directed at himself, and he felt in fairness to Mr. Orme that he (Mr. Lawrie) should state that he had served his apprenticeship to marine ironfoundry, and so could claim to know and understand the methods employed in running turbine castings. He agreed with Mr. Orme that such castings were usually run from the bottom along the flanges, and that top gates were often employed to freshen up the rising metal.

Mr. Lawrie further stated that whilst he was an advocate of top pouring whenever possible, it was obvious that it was not always possible, and even not desirable to do so, and that every job must be considered on its own merits. He further admitted that in one foundry under his control, ten basic mixtures were running every day, and that both top and bottom pouring were employed, chiefly the latter.

MR. HARDING said that undoubtedly top pouring depended on the particular job. Top pouring was preferable from the metal point of view, as it supplied hot metal where it was most needed. There were cases where by ordinary bottom pouring the risers were filled with very cold metal.

### Spinner Gates

MR. H. L. SANDERS said Mr. Harding has laid great stress on the importance of keeping the castings clean, and yet he noticed that in the films the moulds were poured with iron which had not been skimmed, and there was a fair amount of slag on the ladle. It was usual, of course, to hold the slag back, but the chief danger was the first metal going down the downgate and carrying slag with it into the mould. On the question of the spinner, he was rather surprised that Mr. Harding laid such stress on throttling the stream between the downgate and the spinner. In personal experience with whiteheart malleable, a notoriously dirty metal, particularly with small cast-

(*Continued on page* 348.)

## AMERICAN BRONZE FOUNDRIES

The war has served to build and educate many American industries. The bronze alloy industry is one of those whose *modus operandi* has been strongly affected, writes C. J. ZAISER, of the Ampco Metal, Inc., Milwaukee, Wis., in "Steel." Most bronze foundries are small, local in coverage and ill-equipped from a standpoint of control and research facilities. Only a few have adequate control and research facilities to operate on a national scale. All bronze foundries, however, by virtue of the war programme have been forcibly educated in control and in the meeting of specifications through work done for Ordnance, Navy and other federal agencies. These experiences cannot react other than favourably to the industry in the years of peace to come.

A factor adversely affecting the bronze casting industry and which has developed largely during 1942 is the increasingly critical shortage of copper, tin and some other alloying elements. To counteract this shortage, various federal specifications for bronze have been modified to permit of higher impurity content, and various alternate materials have been advanced as acceptable for substitution. Such concessions as these cannot help, but adversely affect the quality of the output of the average bronze foundry, particularly those lacking the measures of control. Users of bronze castings should, and for the most part do, recognise this fact and make allowance therefor.

## OVERSEAS NOTES

SACHISCHE GUSSTAHLWERKE, Döhlen, has again declared a 6 per cent. dividend on its 6,000,000 Rmk. capital. The capital is to be raised by up to 3 million Rmk. by the issue of new shares.

DELIVERIES of finished steel products by the U.S. Steel Corporation in 1942, exclusive of year-end adjustments is estimated at 21,064,157 net tons against 20,416,604 net tons after year-end adjustments for 1941. Deliveries for 1942 were the highest in the history of the Corporation.

DEUTSCHE BERYLLIUM G.m.b.H., (DEBEGE), Stuttgart, has been formed with a capital of 150,000 Rmk. to manufacture and market beryllium, beryllium alloys and salts, to acquire patents in all processes relating to beryllium, and to prospect for and mine the ores. It absorbs a similar Luxemburg company formed in 1936.

THE GERMAN ARMAMENTS MINISTER, Reichsminister für Bewaffnung und Munition, has ordered the adoption of simplified forms for reports and statistical returns, to save 40 to 70 per cent. of the labour and 75 per cent. of the paper hitherto necessary for form-filling. Nothing is stated about the publication of any statistics.

NIPPON SEITETSU, the largest iron and steel producing concern in Japan, has partly changed over to the making of basic-Bessemer steel, hitherto a monopoly as far as Japan is concerned of the Japan Steel Tube Manufacturing Company. Licences to work the process have been granted by the Japanese Iron and Steel Control.

VEREINIGTE DEUTSCHE METALLWERKE A.G., Frankfurt am Main, last March raised its capital from 62 to 70 million Rmk. The net profit of the concern, which controls a large number of non-ferrous industries in the Reich, was 3,112,720 Rmk. in the year to September 30, 1941, from which a dividend of 5 per cent. was paid.

KONINKLIJKE NEDERLANDSCHE HOOGOVENS en Staalfabrieken, Ijmuiden, made a net profit of 810,000 fl. in the year to March 31 last, against 1,310,000 fl. in the previous year. On the principal block of shares of 25,630,000 fl., a dividend of 3 per cent. has been paid, as against 6 per cent. on the old capital of 17,700,000 fl. The total capital has now been increased from 20,280,000 to 25,910,000 fl.

## THE GATING OF CASTINGS

(*Concluded from page* 347.)

ings, he always throttled the metal at the ingate. In that way, with properly proportioned ridge and spinner, it was impossible for any slag to enter. This method was very suitable for small malleable castings, but, of course, could not be applied to larger castings. He asked whether Mr. Harding had any experience with a dummy spinner in which the metal entered and left a small spinner before entering the feeder. Incidentally, the steelfoundries were appreciating the spinner feeder nowadays. There was one fact regarding the relative merits of the ingates in the top and bottom of the casting where either were applicable, where, of course, the casting was not run through a feeder, and there were no shrinkage troubles. Probably the metal entering the bottom entered quietly and the hot entering metal ran through the colder metal and levelled the temperature, so that at the moment of solidification the casting was practically uniform in temperature. Personal experience of bottom ingates was that of cleaner and sounder castings.

MR. HARDING, referring to the slag on the ladle, said he thought he had made this quite clear. The slag was deliberately retained on the ladle to show it in the runner system, but, of course, the ladle was actually cleaned in normal practice. Precautions were taken mainly against the first metal, and that was why, with an ingate on the end of a runner bar, the first metal did the damage at that point. This also applied to the whirl gate. It was not necessary to choke the entrance to the whirl gate, but it was so necessary for the shrink bob. As to the spinner, the metal flowed to the outside first and the angle of outlet was the important point; it must always be in the reverse direction to the inlet.

A cordial vote of thanks was accorded to the lecturer, on a proposition made by MR. W. H. SMITH and seconded by MR. H. P. RADFORD. After MR. HARDING had replied, the chairman closed the meeting.

# MOULDING SANDS AND MATERIALS

## SECOND REPORT OF THE MOULDING MATERIALS SUB-COMMITTEE OF THE STEEL CASTINGS RESEARCH COMMITTEE

### *Section IV.—Economies in the consumption of core compounds and tests made to find economical mixtures*

(*Concluded from page* 310.)

### MEANS OF REDUCING THE CONSUMPTION OF CORE COMPOUNDS

The methods by which the consumption of core binding materials per ton of castings can be reduced may be roughly classified as follows:

(1) Replacement of core sands by green sand or dry sand.
(2) Ensuring that core compounds and binders are used correctly and without waste.
(3) Reduction in percentage of binders in core-sand mixtures.
(4) Addition of a silica flour or clay to core-sand mixtures.
(5) Utilisation of alternative materials, including available waste products.

These methods are referred to in greater detail below, and some examples are given which, it is hoped, will suggest how the consumption of core binders may be reduced in any particular foundry, the course to be adopted naturally varying with local conditions and equipment.

Where small green-sand castings are being manufactured, green-sand cores can in many cases be used instead of oil-sand cores. These green-sand cores collapse after the pouring of the casting almost as well as oil-sand cores, but their application is somewhat limited. In general, the shape of the core must be such that it is well supported in the mould, so that it does not sag. Where there is much overhang, whole green-sand cores cannot be used much, since their mechanical strength is low. Frequently, however, this difficulty can be overcome by turning out green-sand top halves on to dry-sand bottom half cores. Where moulding is done on the floor, or in a pit, much larger green-sand cores can be used, since they can be built up on the spot and do not have to be transportable. Large green-sand cores must be simple in shape; they have frequently been used, for example, in the casting of open-hearth charging boxes.

In many instances, oil-sand cores are used where there is no real necessity to have a collapsible core. In such cases dry-sand cores are frequently strong enough and give good results in practice. Sometimes in green-sand working, inserts of oil-sand are put in front of the runner, or in other places, to minimise erosion during pouring. Runner bushes and similar articles are sometimes made in oil-sand mixtures to provide a standby job in the core shop and to be held in stock. In many cases dry sand can be used equally well for such purposes, but dry-sand parts cannot, of course, be kept in stock.

When core sands are being mixed, both the silica sand and the core compounds or the core binders should be measured as accurately as possible in order to avoid waste. The silica sand may be measured in buckets- or skips-full. Core oils and core creams can be measured by volume, whilst semi-solid compounds are best weighed out. Similarly, linseed oil can be added in pints and dextrin in pounds weight. Water should be added in pints. The silica sand should be cold. If insufficient time is allowed, hot sand may come either from the sand drier, or, if a proportion of reclaimed sand is being used, from the knock-out heap. The milling of warm mixtures encourages drying-off on the core bench. The wastage of core-sand mixtures due to drying-off, some of which is inevitable, occurs with greater readiness as the percentage of dextrin is increased. It may be reduced by the addition of molasses, or by using water in the mixture containing a hygroscopic salt in solution such as ammonium nitrate, or by covering the heaps of sand on the core benches with wet cloths or sacks. Baking of the cores at the correct temperature is necessary for the maximum strength to be obtained from the core binders used, the dry strength of both under-baked and over-baked cores being less than that of correctly baked cores. The time of baking can be minimised by ensuring an adequate number of air changes.

TABLE XXIII.—*Chelford Silica Sand with G.B. Kordek and Linseed Oil.*

A.F.A. test cylinders 2 in. × 2 in.
Samples baked at 200 deg. C. for 2 hrs.

| Mixture. | Permeability No. | Water. % | Green Strength. Lb. per sq. in. | Dry Strength. Lb. per sq. in. |
|---|---|---|---|---|
| 1500 g. Chelford sand<br>17½ g. G.B. Kordek<br>10 c.c. Linseed oil | 94 | 2·5 | 1·9 | 1960 |
| 1500 g. Chelford sand<br>15 g. G.B. Kordek<br>10 c.c. Linseed oil | 111 | 2·7 | 1·35 | 1040 |
| 1500 g. Chelford sand<br>10 g. G.B. Kordek<br>10 cc. Linseed oil | 120 | 2·6 | 0·95 | 610 |

In foundries it is easily possible for unnecessarily large percentages of core-binding materials to be used. Often the same core-sand mixture is used for cores of widely different sizes, shapes and weights. The strength of the mixture is made ample for the most exacting cores, and is far greater than is necessary for some small light cores. Sometimes this is due to

## Moulding Sands and Materials

the small capacity of the mixing equipment, but more often it is due to the fear that confusion may arise if two or three different mixtures are present in the core shop at the same time. Sometimes cores are purposely made very strong to allow for rough handling, but this, in any case, should be avoided. In some instances cores with overhanging parts are made

TABLE XXIV.—*Chelford Silica Sand with Kordol No. 3.*

A.F.A. test cylinders 2 in. × 2 in.
Samples baked at 200 deg. C. for 2 hrs.

| Mixture | Permeability No. | Water % | Green Strength, Lb. per sq. in. | Dry Strength Lb. per sq. in. |
|---|---|---|---|---|
| 1500 g. Chelford sand<br>40 g. Kordol No. 3 | 91 | 4·2 | 1·9 | 1600 unbroken |
| 1500 g. Chelford sand<br>30 g. Kordol No. 3 | 112 | 3·0 | 1·8 | 1500 |
| 1500 g. Chelford sand<br>25 g. Kordol No. 3 | 120 | 3·0 | 1·25 | 910 |

sufficiently strong to be self-supporting, whereas a shaped support would enable a less strong core to be handled safely.

### Experiments on Economy Mixtures

In some foundries core-sand mixtures containing proportions of 4 per cent., 5 per cent. or even more of organic binders are regularly used for all types of core. Table XXIII gives the results of examining mixtures of Chelford silica sand with smaller amounts of G.B. Kordek and linseed oil, the total percentage

TABLE XXV.—*Chelford Silica Sand with Silica Flour and Linseed Oil.*

A.F.A. test cylinders 2 in. × 2 in.
Samples baked at 200° C. for 2 hr.

| Mixture | Permeability No. | Water % | Green Strength, Lb. per sq. in. | Dry Strength, Lb. per sq. in. |
|---|---|---|---|---|
| 1500 g. Chelford sand<br>150 g. Silica flour<br>15 c.c. Linseed oil | 68 | 6·7 | 0·9 | 400 |
| 1275 g. Chelford sand<br>225 g. Silica Flour<br>15 c.c. Linseed oil | 53 | 6·6 | 1·25 | 420 |
| 1200 g. Chelford sand<br>300 g. Silica flour<br>15 c.c. Linseed oil | 42 | 6·7 | 2·1 | 400 |

of binders being 1.8, 1.67 and 1.25 per cent. Even with only 1.25 per cent. of binders the mixture works well; in fact, small cores were successfully made in it and gave satisfactory results on casting. In this case the green strength is inadequate for making large cores or cores with any overhang. In Table XXIV are given the results obtained from Chelford sand mixtures containing 2.7, 2.0 and 1.7 per cent. of a proprietary core compound. All these mixtures have been found perfectly satisfactory for making medium and large cores.

In some cases cores of unusual shape call for mixtures with high green strength. This may be secured by the addition to the mixture of either silica flour or a clay, instead of by using an excessive amount of core compound. Silica flour will not interfere with the collapsibility of the core after casting, whereas added clay will retain much of its bonding strength after the casting is poured. In both cases, although the green strength is increased, the dry strength is reduced, and this imposes a practical limit on the amount of silica flour or clay which can be used. The presence of these fine materials in the mixture makes the sand less easy to work on the core bench, diminishes the plasticity of the sand mixture and also lowers the permeability of the sand. Table XXV illustrates the effect of adding silica flour to a mixture

TABLE XXVI.—*Silica Sands with Core Binders and Clay.*

A.F.A. test cylinders 2 in. × 2 in.
Samples baked at 200 deg. C. for 2 hrs.

| Mixture. | | Permeability No. | Water. % | Green Strength. Lb. per sq. in. | Dry Strength. Lb. per sq. in. |
|---|---|---|---|---|---|
| No. | Proportions. | | | | |
| 1 | 1000 g. Chelford sand<br>500 g. Old green sand<br>40 g. Kordol No. 3 | 87<br>75 | 3·5<br>5·2 | 4·8<br>4·1 | 680<br>500 |
| 2 | 1000 g. Chelford sand<br>500 g. Old green sand<br>20 g. Truline<br>20 g. Sulphite lye | 108 | 2·5 | 3·25 | 430 |
| 3 | 1500 g. Chelford sand<br>10 g. Fulbond No. 1<br>45 g. Truline<br>15 g. Sulphite lye | 73 | 3·75 | 3·2 | 510 |
| 4 | 1000 g. Chelford sand<br>750 g. Kings Langley red sand<br>15 g. G.B. Kordek<br>15 g. Truline | 94<br>94 | 5·2<br>5·7 | 5·2<br>3·8 | 530<br>630 |
| 5 | 1200 g. Leighton Buzzard No. 9<br>300 g. Kaybond<br>30 c.c. Linseed oil | 82 | 5·1 | 4·0 | 750 |
| 6 | 1200 g. Chelford sand<br>300 g. Kaybond<br>30 c.c. Linseed oil | 26 | 6·7 | 3·8 | 680 |

of Chelford silica sand and linseed oil. As the proportion of silica flour increases, the green strength increases with no significant change in the dry strength, the permeability being also diminished.

Other mixtures containing clays as well as core binders gave the results shown in Table XXVI. The first mixture included old green sand which contained about 5 per cent. of Fulbond No. 1, and the results may be compared with those of a similar mixture without any clay shown in Table XXIII. With the clay mixture the green strength is increased and the dry strength reduced very considerably. There is here no reduction in core binder but a readjustment of green and dry strength. In the second mixture the Kordol was replaced by Truline and sulphite lye, giving somewhat lower green and dry strength, and the mixture proved rather sticky in the core shop. In the third mixture a direct addition of Fulbond No. 1

was made and the proportions of Truline and sulphite lye were varied; this mixture was made into small cores which proved satisfactory, although care was necessary in withdrawing the cores, as they were inclined to adhere to the corebox. The fourth mixture contained clay only in the form of a thin film round the grains of the King's Lynn red silica sand. It was used successfully in making cores for a steel casting weighing about 1 ton.

It will be noticed that mixtures 2, 3 and 4 contained the resin Truline in place of linseed oil. It was found that in baking the mixtures some of this resin was liable to volatilise, leaving a weaker surface.

TABLE XXVII.—*Experiments with D.C.L. Slop.*
A.F.A. test cylinders 2 in. × 2 in.
Samples baked at 200 deg. C. for 2 hrs.

| Mixture. | | Permeability No. | Water. % | Green Strength. Lb. per sq. in. | Dry Strength. Lb. per sq. in. |
|---|---|---|---|---|---|
| No. | Weights. G. | | | | |
| 1 | 1470 Chelford sand<br>30 Slop | 144 | 0·6 | 0·9 | 180 |
| 2 | 1455 Chelford sand<br>45 Slop | 132 | 0·9 | 0·6 | 630 |
| 3 | 1455 Chelford sand<br>45 Slop<br>10 Dextin<br>5 Fulbond No. 1 | 150 | 0·9 | 1·8 | 600 |
| 4 | 1455 Chelford sand<br>45 Slop<br>10 Dextin<br>5 Fulbond No. 1<br>10 Linseed oil | 143 | 0·9 | 1·9 | 860 |
| 5 | 1455 Chelford sand<br>45 Slop<br>10 Linseed oil<br>5 Fulbond No. 1 | 137 | 0·9 | 1·1 | 1010 |
| 6 | 1455 Chelford sand<br>45 Slop<br>5 Dextrin<br>5 Fulbond No. 1<br>10 Linseed oil | 137 | 0·9 | 1·8 | 1020 |
| 7 | 1455 Chelford sand<br>45 Slop<br>10 Dextrin<br>10 Linseed oil<br>15 Fulbond No. 1 | 162 | 0·9 | 3·6 | 740 |
| 8 | 1425 Chelford sand<br>45 Slop<br>30 Fulbond No. 1 | 158 | 1·8 | 2·4 | 90 |
| 9 | 1305 Chelford sand<br>45 Slop<br>150 Kaybond | 100 | 2·1 | 1·2 | 130 |
| 10 | 1500 Chelford sand<br>15 Slop<br>15 G.B. Kordek<br>6 Linseed oil | 120 | 2·0 | 1·6 | 550 |
| 11 | 1500 Chelford sand<br>15 G.B. Kordek<br>15 Slop | 150 | 1·5 | 1·8 | 160 |

This tendency may be avoided by applying part of the resin dissolved in a volatile organic solvent as a coating, which for small cores may be sprayed on before stoving and for heavy cores brushed on after stoving. In mixtures containing silica sand with no added clay or reclaimed sand, better results can be obtained if the linseed oil is not omitted entirely but is replaced in part by using resin dissolved in linseed oil. In mixture 5 the base sand was Leighton Buzzard No. 9, which is coarse in grain size, whilst No. 6 contained Chelford sand, the grains of which are of medium size. The effect is seen in the permeability number, which, at the moisture used, is very low in the case of the Chelford mixture. Both these mixtures had high green strength with dry strength adequate for small cores, but they were somewhat lacking in plasticity. The clay used, Kaybond, is much more refractory than the Fulbonds, but less efficient as a clay binder.

### Use of Industrial Waste, etc.

The members of the Sub-Committee have carried out experiments with several industrial waste and by-products in endeavours to find materials of value as core binders, and the results of one such investigation are shown in Table XXVII. The material, D.C.L. Slop, is a viscous liquid resembling molasses in appearance. The first seven mixtures incorporate various proportions of dextrin, Fulbond No. 1 and linseed oil, using Slop as the main binder. Mixtures 8 and 9 contain only Slop as organic binder, with additions of Fulbond No. 1 and Kaybond respectively. The dry strength of these was inadequate, both mixtures giving weak friable cores. Mixtures 10 and 11 are alike except for the presence of linseed oil in No. 10. The absence of this oil in No. 11 is responsible for the much lower dry strength.

Mixture No. 4 appeared promising from a practical point of view. On trial it worked easily in the core shop, did not air-harden and gave hard cores after baking. Cores were successfully made in it and used in a number of castings. Mixtures 5 and 6 were somewhat similar in constitution and also behaved quite well. The linseed oil present, apart from increasing the dry strength, also improved the ease of stripping from the core box.

By-product materials of this type can be utilised as foundry binders in two different ways. Where foundries make up their own mixtures from core-binding materials, the by-product can be added as a constituent of the mixture. Alternatively, the by-product can be used by manufacturers as core compounds in making up core creams or semi-solid compounds. This is probably the more economic method of utilisation, since the mixing and blending of core-binding materials can be carried out more efficiently by the core-compound manufacturers than by most foundries.

## CONCLUSION AND RECOMMENDATIONS

In view of the shortage of materials ordinarily used for making core compounds, core sands consisting of silica sand and organic binders should not be used except when really necessary. Foundries using ready-made core compounds are recommended to try core-sand mixtures containing smaller proportions of core compounds than they have normally used. The arrangements for handling cores, both before and after baking, can frequently be improved without much difficulty, and the need for excessive strength in cores thus reduced. Core creams should be used instead of semi-solid compounds wherever possible. Foundries making up their core sands from dextrin, linseed oil and other core materials should also carry out experi-

(*Concluded on page* 357.)

# COPPER-BASE ALLOY SCRAP

## SEGREGATION AND RECLAMATION

At the recent annual meeting of the American Institution of Metallurgical Engineers, MR. L. S. DEITZ, JUN., of the Nassau Smelting & Refining Company, Inc., presented a Report to the symposium dealing with the problems of the consumer of non-ferrous scrap, *viz.*, the smelter and refiner who melts selected scrap and produces foundry ingots of specified compositions or billets for rolling or extrusion in non-ferrous mills. Confining his remarks to the copper-base alloys, since in the sorting, melting and refining of these alloys probably all the usual types of problems are encountered, he pointed out that, while metallurgical processes are available for separating copper-base alloys into their primary constituents, especially copper and tin, it is more economical to melt a selected scrap such as red brass, refine the molten metal to a definite alloy specification and cast the alloy into ingots for further processing. This economic advantage is the chief reason for the existence of the secondary metal refinery, and its present prominence is due to the demand of the American war industries for large tonnages of foundry ingots and billets, as well as to the restrictions on the use of primary metals for making foundry casting alloys.

This economy can be realised only if the scrap items are sorted into classes with impurities corresponding as nearly as possible to their original compositions. The chief reason for this is the fact that metallurgical processes are available only for the removal of certain impurities. The scrap items which contain elements which cannot be removed without excessive loss are less desirable for the more important alloys and must fall into a lower value class. Thus no means are available for removing even small amounts of lead from copper alloys containing tin and zinc without resorting to the more expensive procedure of separating, also, the zinc and the tin from the copper. It is, therefore, imperative to keep high-lead alloys separate from high-tin, low-lead alloys.

Also, no methods for removing aluminium, silicon and manganese from copper-base alloys containing a high zinc content, such as brass, are available without sacrificing a large percentage of the zinc. Similarly, iron which cannot be removed magnetically and sulphur are only removed with difficulty from red brass alloys.

### Identification and Sorting

Many producers or dealers of scrap do not appreciate the necessity of keeping aluminium-bronze, manganese-bronze and yellow brass turnings separate from Navy "G" or Navy "M" turnings, or are not sufficiently skilled in their identification of scrap to recognise these alloys, reports the author, while others do not appreciate the necessity of keeping leaded brass from these high-grade turnings. In addition to this, they are debasing these materials and creating an economic waste.

Copper alloys containing silicon are difficult to identify once they become mixed with other copper-base alloys and, where possible, they should be segregated, since silicon is detrimental in alloys containing lead and tin. The author has noted that some suppliers of scrap do excellent sorting and others do a very poor job. It takes time and effort to train men to distinguish certain types of scrap, but this effort is necessary, especially at this time, in order to be able to use the scrap to its best advantage.

The ingot producers in general have established a practice where they will accept certain types of scrap only in large loose bales rather than in small compressed briquettes in order to be able to inspect them readily. This is important with copper scrap and old sheet brass scrap of low lead or low tin content where it is imperative that higher lead, tin or iron material, if present, be removed prior to melting. If scrap is delivered in a loose bale, it can be inspected throughout and this creates a moral urge on the part of the supplier to sort more carefully.

The author's firm has had periodic difficulty with deliveries of brass pipe and brass scrap containing small but objectionable percentages of brass-plated steel. Also, copper-base alloy turnings containing iron turnings and an excessive amount of oil are always a source of trouble. In many cases, the iron turnings cannot be removed by the ingot manufacturer or the supplier by magnetic means, since they are interlaced with copper turnings or become attached to the oil. Therefore, where possible, it falls on the machine shop to segregate the iron turnings from the copper-base alloy and to remove the excess oil. Due to the diversion of mill scrap to the brass mills, it is necessary to use larger percentages of turnings than formerly, in nearly all of their furnace charges, in some cases up to 80 per cent. of the weight of the charges. Suppliers should exert every effort in training machine-shop workers to segregate their turnings at their machines and, where possible, remove the excess oil. The author considers that the ferrous and the aluminium industries are ahead of the copper-base industry in this respect.

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**Consumption of iron and steel** in Sweden in 1942 is provisionally estimated at one million tons, 100,000 tons more than in 1941 and against an average of 860,000 tons in 1932-41. The building industry took only about a quarter of the 300,000 to 400,000 tons of iron and steel which it normally absorbs each year. Rolled-steel output last year was between 850,000 and 900,000 tons against the 1937 record total of 775,000 tons. The output this year is expected to be maintained in spite of scrap difficulties.

**United States capacity** for high-grade alloy steel ingots and castings has been very greatly increased by the installation of new electric-arc furnaces. During 1942, one manufacturer accepted orders for the transformers and control equipment for more than sixty electric arc steel-melting furnaces of a total capacity of about 415,000 k.v.a. Twenty-two of the furnaces are of 50 tons or greater capacity and involve transformers of 12,000 k.v.a. and 15,000 k.v.a. One company now operates twenty-five arc furnaces supplied from transformers totalling more than 260,000 k.v.a. capacity.

# ACID RESISTANCE AND TECHNICAL CONTROL IN AN ENAMELLING PLANT

## CONCLUSION OF PAPER AND DISCUSSION

(*Concluded from page* 334.)

The "cast-iron" cover shown in Fig. 24 reveals an enamelled surface extremely defaced by pin-hole defects. This was annealed at a high temperature for a considerable length of time, and many attempts to enamel it resulted in failure. Subsequent analysis and micro-examination proved the article to be a blackheart malleable iron casting. The very low carbon and silicon contents suggested that no breakdown of the eutectoid cementite was possible with ordinary shop furnace practice. The micrograph (Fig. 25) bears out this contention. The specimen sectioned through the enamel-metal interface shows a structure of temper carbon nodules in a matrix consisting of ferrite and pearlite.

Such general blistering could not have been caused by gas evolution from the free graphite, because it will be seen that the surface of the casting consists of a layer relatively free from carbon nodules. Pearlite is noticeable in this layer, and this indicates that decarburisation of the surface layer is incomplete. The structure of the metal at the enamel-metal interface is, in effect, that of a 0.67 per cent. carbon steel. The point to notice is that, although this door invariably blistered with high-temperature enamels, it behaved more rationally when low-fusing enamels were fired on. These contradictory phenomena may be theoretically explained by both the hydrogen and the carbon-oxide hypotheses.

Iron carbide will oxidise only in the higher temperature range, and therefore the evolution of carbon monoxide or carbon dioxide could only be expected to occur at elevated temperatures. If hydrogen is the accepted cause, it is difficult to understand why diffusion does not occur at the lower firing temperatures. The hydrogen is not very soluble in ferrite, but is strongly bonded to the iron carbide. It may be that, at the critical point when the pearlitic carbide goes into solution in the austenite, hydrogen is released and diffuses to the surface. Certainly, when it is considered that these castings may have been in contact with damp mill scale and iron oxide during the annealing cycle, hydrogen must remain suspect.*

Recent experiments on austenitic steels of the 18:8 type showed that when enamel was fired on at temperatures above the critical annealing range (when all the carbides are in solution), it fired down very successfully. When furnaced within the temperature range which results in the precipitation of carbides and the accompanying intergranular corrosion, this material gave rise to delayed popping or fish-scaling. Below each scale was a minute gas hole, indicating that gas had been evolved during firing, but that the pressure had been insufficient to break the enamel surface. From the delayed action effect it would appear that gas was still being evolved after the metal had cooled, and that the pressure set up had eventually blown the enamel off. At the higher temperature firing, the hydrogen was probably released when the carbides went into solution in the austenite and escaped through the fluid enamel. Although these deductions fit in with the hydrogen theory, quite a few things are taken for granted.

* The Author has inadvertently referred to the whiteheart process—Ed itor.

### Effect of Copper-containing Irons on Adherence

From the author's tests on the adherence of silicate coatings to copper-containing cast irons the following ideas emerge. A thin film of copper oxide probably forms on the surface of the iron, protecting it from excessive oxidation and affording the enamel better grip. It is well known that metallic cobalt, under certain circumstances, plates out of the enamels containing the oxide, and that the electro-deposited coating of cobalt on iron produces better adherence.

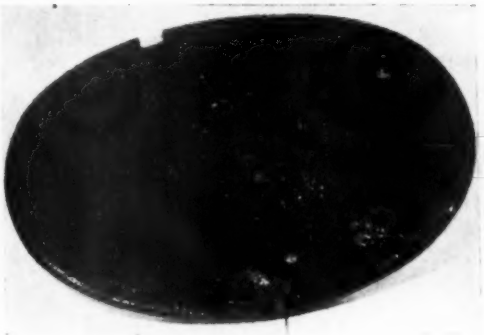

FIG. 24.—ENAMELLED MALLEABLE IRON DOOR SHOWING BAD BLISTERS.

Amberg, Prior and Richmond (THE FOUNDRY TRADE JOURNAL, Vol. 57, 1094) found that, by electro-depositing a film of molybdenum hydroxide on steel, better adherence was obtained. They stated that a suitable metal should have at least some of the properties of cobalt. It should be in such a position in the electromotive series that iron will replace it in solution; it should have more than one valency; it should have a melting point above the firing temperature of the enamel. Copper is favourably placed with regard to these requirements. Their experiments were conducted using molybdenum oxide to obtain the necessary amount and kind of oxide film on the iron surface to promote adherence.

Copper, slightly in excess of the solubility limit in cast iron, gives just this very thin film of copper oxide which, as well as protecting the iron surface from excessive oxidation gives better "wetting" of the metal surface and hence superior adhesion. The submicroscopic suspension which is dispersed through

the metal, in addition to the amount in true solution, adds to this effect. Thus, when castings are heated in air at the normal firing temperatures a measure of protection is afforded.

In the tests under consideration, the ordinary iron plates showed a distinct tendency to oxide and scale formation, while those containing copper remained bright and comparatively scale-free even after prolonged annealing. It seems that if the iron oxide layer is too thick the enamel is incapable of dissolving it and thoroughly wetting the iron, and that the copper addition appears to exercise the necessary control over the oxide formation.

Recapitulating, the following are the advantages

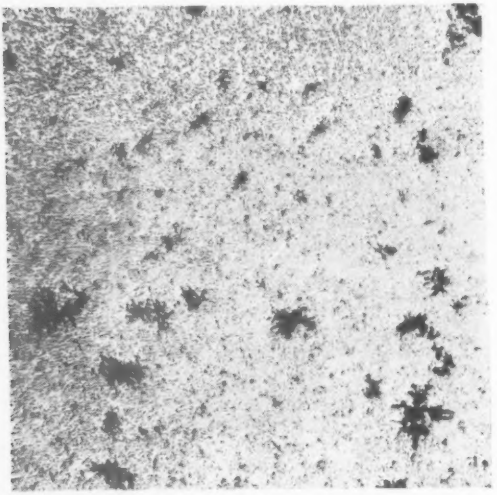

FIG. 25.—MICROGRAPH OF MALLEABLE CAST IRON (SHOWN IN FIG. 24), ETCHED WITH 4 PER CENT. PICRIC ACID IN ALCOHOL (× 60). CONSIDERABLE PEARLITE PRESENT.

which these tests indicate will accrue from the use of copper in engineering quality cast iron for enamelling.

(1) The fluidity of the metal is increased and hence the lack of phosphorus is partly counterbalanced by copper additions and the mould impression more clearly delineated in castings of intricate section.

(2) A refinement of the graphite structure gives pressure tightness and inhibits gas formation during firing, as, by virtue of the smaller graphite flakes, less oxidation and formation of the debatable oxides of carbon can take place at the enamel-metal interface.

(3) The eutectoid point occurs at a lower temperature when copper is present in cast iron and shorter annealing times are necessary to complete the carbide breakdown.

(4) The copper oxide skin controls the degree of surface oxidation of the iron at, and under, firing temperatures and gives a stronger grip to the ground coat.

The above notes and related deductions apply, for the most part, only to the enamelling of a general engineering type of cast iron. Certain of the findings, however, might be of general interest to the light-castings enamellers, who, at a future and more propitious time, might be inclined to investigate them further.

## Conclusion

A great amount of fundamental research is necessary before cast iron can be fully developed as a base for resistant silicate coatings. Doubtless, new methods such as X-ray diffraction analysis and new tools such as the electron microscope will, some day, elucidate many debatable ceramic questions. An attempt has been made in this Paper to emphasise the importance of chemically-resistant enamels as applied to mild steel and cast iron, and to draw attention to the technical control necessary for their production. The potentialities of these glass coatings and linings, for the future, need no stressing. Millions of pounds sterling are lost each year due to the ravages of corrosion and one of the durable protections of cast-iron and steel structures is a coating of fused silicate glass.

While, in many cases, cast-iron enamellers have gone into temporary eclipse, there may be a small degree of comfort to the industry in the knowledge that at least one section is contributing handsomely to the total war effort.

The writer's thanks are due to Mr. William L. Burns, managing director of Enamelled Metal Products Corporation (1933), Limited, for permission to publish the preceding notes; to Mr. Lindsay Burns, general manager, and to the staff for their much-appreciated co-operation.

## DISCUSSION

The CHAIRMAN (Mr. Geo. Wilson), complimenting the lecturer on the interesting way he had unfolded an absorbing subject, opened the meeting for discussion. MR. J. A. DONALDSON (Carron) asked whether Armco iron had been tried for the vessels illustrated or, alternatively, material of a similar kind. Further, he would appreciate any information available as to the possible decrease in heat conductivity of carborundum bricks after use in the muffle furnace.

In reply, MR. MONTGOMERY said that he had not found it feasible to use Armco iron over a certain gauge; hence mild steel had been found to be cheaper and could be obtained in the heavier gauges required. In the case of special welds, particular attention was paid to the carbon content. He had not found any decrease in heat conductivity of the carborundum

(*Continued on page* 356.)

# CAST ARMOUR FOUNDRY

## AN AMERICAN DEVELOPMENT

The illustrations on this page show operations at a new American cast-armour foundry. The picture on the right shows the setting of a tank turret core. Large arbours are baked into the core, to which is attached the cross arm visible in the photo. The arm is clamped to the flask. This huge one-piece core is baked in a special oven which permits lowering the core directly into the oven from above. This plant is devoted solely to the production of cast-armour parts. The picture immediately below shows a moulding bay in the same plant, with open turret moulds in the foreground and moulds for smaller pieces in the background. In the upper centre is a sandslinger used for ramming up large moulds. The operation of pouring a tank turret mould with a bottom-pour ladle is shown on the right below. The extensive clamping devices should be noted. The pictures, which are reproduced by the courtesy of "The Iron Age," illustrate a development which is essentially American and has been made possible by the enlightened and progressive policy pursued by the leaders of the steel castings section of the industry.

# SPONGE IRON IN THE UNITED STATES

## REPUBLIC STEEL'S VENTURE

The sponge-iron controversy in the United States recently has excited a good deal of interest and not a little caustic comment. The fact remains, however, that the Republic Steel Corporation is erecting a plant at Warren, O., financed to the extent of $450,000 by the Defense Plant Corporation, at the recommendation of the War Production Board. It should be understood, says "Steel," that the special-purpose sinter to be made in this plant is a wartime measure only, as now visualised. Republic has been having a hard time obtaining uncontaminated scrap for its electric furnaces in Northern Ohio and has gone to the length of bringing uncontaminated plate scrap all the way from Birmingham, Ala. The sinter to be made at Warren is to be used in lieu of uncontaminated scrap. It is expected to cost several dollars more a ton to produce this sinter than it costs to make pig-iron. Hence no place is seen for this sinter after the emergency eases and uncontaminated scrap becomes more plentiful.

There are highly special conditions which make the venture possible. It is possible because, first, the company has high-grade magnetic ore in its Port Henry and Chateaugay mines. It is low in silica and is delivered in the form of concentrate containing 64 to 68 per cent. iron. The other factor that makes Republic's venture possible is that at Warren it has available desulphurised coke-oven gas containing the large amounts of hydrogen required to reduce the ore. The ore is to be charged into a furnace of the Herreshoff roaster type, 15 ft. high and lined with inclined hearths. As the ore falls from hearth to hearth, it will be in continual contact with a stream of gas heated to 1,200 deg. F. After losing part of its hydrogen content, the gas will go back into the mains for use in the various steelmaking operations. No attempt will be made to remove all the oxygen. Neither will any steps be taken to remove gangue. The sinter is expected to analyse around 85 per cent. iron, 5 to 7 per cent. gangue, with iron oxide as the remainder.

Herman Brassert and A. T. Cape, who developed the process to be used by Republic, already have used it experimentally to produce sinter from ore obtained from the Scrub Oaks mine in New Jersey, so that, although the practice at Warren remains to be refined, there are good grounds for expecting it to be satisfactory. The product turned out by Brassert and Cape took the form of nodules. Republic plans to discharge from the reducing unit while the sinter still is hot, through a pair of rolls. The product will be ½-in. flat cake which will be broken into convenient charging size. Output will be about 100 tons daily, equivalent to about 3 per cent. of Republic's total requirements of uncontaminated scrap. If results are good with this initial unit, Republic could instal some five or six more at its other plants where hydrogen-bearing coke-oven gas is available.

The Bureau of Mines is investigating a number of sponge-iron processes and the programme is said to have been started with high hopes, but without any definite promises. Three of the processes to be investigated by the Bureau in private plants are reported to have produced sponge iron successfully on pilot scale. One of the private companies producing a similar material is known to have been in continuous production 24 hrs. a day for more than a year. The sponge-iron programme of the Bureau is under the direction of Dr. R. S. Dean, assistant director, who is in overall charge of the work of the Bureau.

# ACID RESISTANCE AND TECHNICAL CONTROL IN AN ENAMELLING PLANT

(*Concluded from page* 354.)

bricks. In the normal practice, there were very few drafts present in the muffles discussed, and failure of the carborundum lining was usually due to the general collapse of the wall.

MR. BIDDULPH (Wolverhampton) asked whether, in the reflux resistivity test, the article tested is a particle of frit, or an actual part of an enamelled surface. Further, was the etched surface mentioned, frit or enamelled surface? He likewise expressed interest in the plotting of cooling curves. Would Mr. Montgomery enlighten him as to the range of fusion temperatures?

MR. MONTGOMERY replied that the test mentioned used powdered and graded frit, thus giving maximum surface contact. In the test-cup method, where the liquid was boiled for a lengthy period, use was made of a part of the enamelled surface. For the etched surface illustrations, the finished enamel, after fusing to the metal surface, was used, the etching agent being 20 per cent. HF in alcohol at room temperature. The range of fusion temperatures varied greatly, high Pb enamels having a low range, say 500 to 600 deg. C., while the high-silica glasses would be round about 900 deg. C.

MR. CURRIE asked whether Mr. Montgomery thought it feasible that, using cast iron, pressures up to, say, 100 lbs. per sq. in. could be an economic proposition.

The LECTURER said he thought it was quite feasible, and mentioned how the enamel layer helped pressure tightness.

Replying to Mr. R. R. Shaw (Larbert), as to whether there was any excuse for non-acid-resisting enamels, MR. MONTGOMERY said it was all a question of the different types of acid resistance looked for in industry. For example, the acid resistance aimed at by him would not be generally useful for, say, cooking utensils, etc.

Mr. Montgomery was accorded a very hearty vote of thanks, on the call of the chairman.

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**Some Job!**

A writer in "The Stabilizer" tells how a 75-ton steel casting, apparently cast too cold, was reclaimed by welding. It required 3 tons of welding rod and 29 days of 24 hours to effect an apparently successful repair.

## OBITUARY

MR. FREDERICK GURDON PALIN, a director of the British Metal Corporation, Limited, died recently, aged 72.

MR. JOHN OWEN REID, late of Anderson & Reid, Limited, ironfounders, of Govan, Glasgow, has died.

MR. NORMAN ROBINSON, managing director of Macrome, Limited, died recently while on a business ham, has died, aged 60.

MR. ERNEST GEORGE DEAKIN, managing director of Wm. Deakin & Company, Limited, brassfounders and makers of steel pressings and stampings, of Birmingham, died last week, aged 60.

MR. HENRY JOHN PRATT, founder of the firm of Harry J. Pratt & Company, Limited, art metal workers and hearth furniture manufacturers, of Birmingham, died last week, aged 79.

MR. JOHN CAWLEY, who for 56 years was with the late firm of John Milburn & Company, mechanical engineers, Hawshead Foundry, Workington, and was works manager for 40 years, has died at the age of 87. He retired 15 years ago.

MR. W. E. PICKFORD, of Sheffield, chairman of Hattersley & Davidson, Limited, manufacturing engineers, Robert Sorby & Sons, Limited, tool manufacturers, and of the Vololo Corrugated Steel Cask Company, Limited, and a director of the Union Grinding Wheel Company, Limited, died recently, aged 60, after a long illness.

LIEUT.-COL. EDWIN KITSON CLARK died at Leeds on April 15. In 1888 he entered the Airedale Foundry of Kitson & Company, Limited, engineers and ironfounders, of Hunslet, Leeds, and was successively apprentice, foreman, works manager, partner, and, after the firm was incorporated as a limited liability company, director and chairman. He was a past-president of the Institution of Locomotive Engineers and the Institution of Mechanical Engineers. Lieut.-Col. Kitson, who was 77 years of age, had not been in good health for some months past.

FLYING-OFFICER GERALD P. KING, R.A.F.V.R., previously reported missing from operations over Germany, is now presumed killed in action, we regret to learn. Son of Mr. E. G. King, chairman and managing director of The Louis Cassier Company, Limited, publishers of our contemporary, "Iron and Steel," among other periodicals, he managed the advertisement department of that journal. He also planned and produced the "Machine Shop Magazine," which was attended with marked success. Forsaking, at his father's wish, the insurance business in which he was making remarkable progress, he displayed outstanding ability in an entirely new sphere. A member of the Civil Air Guard, the urge to play an active part in the war led him to join the R.A.F. Being over age for a pilot, he managed to get himself accepted as an air-gunner and took part in some of the heaviest raids over enemy territory. Gerald King, who was 40 years of age, enjoyed a wide circle of friends who, while mourning his death, will regard with admiration the manner of his passing.

## NEW TRADE MARKS

*The following applications to register trade marks appear in the "Trade Marks Journal":—*

"GLOVERS"—Electric cables and wires. W. T. GLOVER & COMPANY, LIMITED, Trafford Park, Manchester.

"FARRAR BOILERS" and device—Boilers. FARRAR BOILERWORKS, LIMITED, The Spitals, Northgate, Newark-on-Trent, Notts.

"TUNKRO TOOL METAL"—Tools. BROOKE TOOL MANUFACTURING COMPANY, LIMITED, 338, Warwick Road, Greet, Birmingham, 11.

"KANTHAL"—Electric regulating resistances, etc. AKTIE-BOLAGET KANTHAL, c/o Marks & Clerk, 57/58, Lincoln's Inn Fields, London, W.C.2.

"I.C.I."—Non-ferrous metals and alloys, furnaces, boiler tubes, etc. IMPERIAL CHEMICAL INDUSTRIES, LIMITED, Wexham Road, Slough, Bucks.

"CONSOL"—Steel flooring, safes and metal strongroom doors. CONSTRUCTORS, LIMITED, Nickel Works, Tyburn Road, Erdington, Birmingham, 24.

"SPRA-BONDERIZED"—Partly-wrought common metals, metal furniture, etc. PYRENE COMPANY, LIMITED, Great West Road, Brentford, Middx.

"BMC" and ingots device—Aluminium alloys. BROOKSIDE METAL COMPANY, LIMITED, Astra Works, Harland Estate, Honeypot Lane, Stanmore, Middx.

"SKYLUX"—Metal window and door fittings and furnishings and hand tools. SKYLUX, LIMITED, 30, Brunel Road, Old Oak Common Lane, Acton, London, W.3.

"TOWER"—Welding wire and rods and welding machines. A. S. YOUNG & COMPANY, LIMITED, Tower Works, Woodside Lane, North Finchley, London, N.12.

"ALLOYDISING"—Alloys of iron and aluminium. IVOR LLOYD, No. 16 Factory, Morden Factory Estate, Lombard Road, South Wimbledon, London, S.W.19.

"MOLYCOP"—Grinding balls of molybdenum alloy steels. SHEFFIELD STEEL CORPORATION, c/o Frank B. Dehn & Company, Kingsway House, 103, Kingsway, London, W.C.2.

## MOULDING SANDS AND MATERIALS

(*Concluded from page* 351.)

ments using reduced proportions of these materials, aiming especially at decreasing the proportion of dextrin in the mixtures.

Where cores are made in the same shop in a variety of sizes and shapes, they should be classified according to the green and dry strengths required, and different core compounds used for each class, small or simple-shaped cores naturally requiring a smaller proportion of core compound than others. To obtain the most economical results from organic binders, it is essential to weigh or measure out both the sand and the binder and to mill the mix thoroughly. To avoid waste, core sands should not be allowed to dry off on the bench; the easiest way to avoid this is to keep them covered up.

## NEWS IN BRIEF

LAWSON ENGINEERING COMPANY, LIMITED, 25-26, Hanover Square, London, W.1, is being wound up under an Order made by the High Court.

TARRAN INDUSTRIES, LIMITED, engineering contractors, have increased their authorised capital to £600,000 by the creation of 2,000,000 2s. ordinary shares.

THE COMPANIES REGISTRATION OFFICE gives notice that the Kitson Engineering Company (London), Limited, has been dissolved and its name struck off the register.

THE CONTROL OF MICA will in future be exercised by a special section of the Non-Ferrous Metals Control, under Mr. G. F. A. Burgess as controller. All communications relating to requirements of mica should be addressed to the Mica Control, South Wing, Somerset House, London, W.C.2.

PRIVATE ENTERPRISE with the profit motive was the best insurance of a healthy revival of our industries after the war, said Mr. Colin Laycock in his presidential address to Sheffield Chamber of Commerce. We should retain all of that which had been proved sound, and not change merely for the sake of changing.

CANADA MAY BECOME a leading producer of magnesium following the discovery by H. G. Wildman of a process by which magnesium chloride can be extracted from asbestos "tailings." The 20,000 tons of asbestos tailings that are dumped in Canada every day would produce 3,000 tons of magnesium by the Wildman process, it is estimated.

DAVY & UNITED ENGINEERING COMPANY, LIMITED, and Duncan Stewart & Company, Limited, announce that as a result of the reorganisation of their sales arrangements, Mr. H. J. Munro, 25, Victoria Street, London, S.W.1, has ceased to represent them. The London office of these companies is at Abbey House, 8, Victoria Street, London, S.W.1.

DUE TO THE CONCENTRATION policy of the Iron and Steel Control, blast furnaces of William Dixon, Limited, Glasgow, have been closed, it is reported. The loss of output will be compensated for by increased production at other plants in Scotland, and the men who are being displaced will be employed elsewhere. "Dixon's Blazes" were started more than a century ago. The coke ovens will not be affected.

THEIR ENGINEERING WORKS had expanded their production of armaments of every description, said Mr. A. A. Jamieson at the annual meeting of Vickers, Limited. The demands upon the capacity of the English Steel Corporation, Limited, had been intensive. The Corporation had delivered an increased supply of both steel and of machined products. They had also given much technical information to other companies.

"OUR RICH HEMATITE ore is more vital to victory than all the gold held by banking institutions," declared Mr. J. Harvey-Davies, general manager of the Keswick Granite Company, Limited, in an address on "The Stagetic Minerals of Cumberland," at Cockermouth. With a little more foresight, our garden and other ornamental ironwork might have been saved, he said. Mr. Davies laid emphasis on the necessity of never again allowing a state of dereliction to arise in the iron-ore districts such as was tolerated after the last war.

THE MINISTER OF LABOUR and National Service has made the Factories (Canteens) Order, 1943, which amends the Order made in November, 1940. Under it, the Chief Inspector of Factories, acting on the Minister's behalf, can, if he considers it necessary, give binding directions that the occupier of any factory employing more than 250 employees and engaged on essential work must provide a factory canteen. The old Order only applied to factories engaged on munitions or any work on behalf of the Crown. It also provides a new procedure for intervening if the service actually provided in any such canteen is unsatisfactory.

LARGE FACTORIES whose towel ration for 1943 works out at 100 coupons or more are being given part of this in the form of coupon-equivalent certificates marked "Series Two." These "Series Two" certificates do not become valid until July 1, 1943, and under a General Licence, S.R. & O., 1943, No. 154 (obtainable, price 1d., from H.M. Stationery Office or through any bookseller) may, if properly endorsed, be used for the purchase of towels on and after that date. The object of deferring part of the larger rations in this way is to lessen the demand on present stocks which might otherwise be insufficient for all immediate needs.

## PERSONAL

MR. A. MURRAY STEPHEN, chairman of Alex. Stephen & Sons, Limited, Linthouse, Glasgow, was elected president of the Institution of Engineers and Shipbuilders in Scotland at the annual meeting in Glasgow.

MR. W. F. BISHOP has relinquished his position as general manager of W. T. Henley's Telegraph Works Company, Limited, but remains on the board. Mr. F. W. M. Anderson has been promoted to general manager and Mr. G. E. Rhodes becomes assistant general manager.

SIR LAWRENCE BRAGG, Cavendish Professor of Experimental Physics in the University of Cambridge, has left for Sweden, where he will give a series of scientific and popular lectures under the auspices of the British Council, including one for specialists on "The Strength of Metals."

## ENGINEERING WAGES AWARD

Members of the Amalgamated Engineering Union have been warned by their Executive Council not to be led into unofficial action, which was contemplated in certain parts of the country, against the recent National Arbitration Tribunal award. A statement issued by the Executive Council says that an explanation of the award has been circulated to all branches and districts. The award will improve the wages of the lower paid workers and rumours that earnings are to be reduced as a result of it are false. Certain piece and day workers will not receive an increase. Arrangements are in hand for a meeting of the National Engineering Joint Trades Movement to decide what further representations are appropriate and desirable.

# STANTON

*Dale*

**REFINED**

# PIG IRON

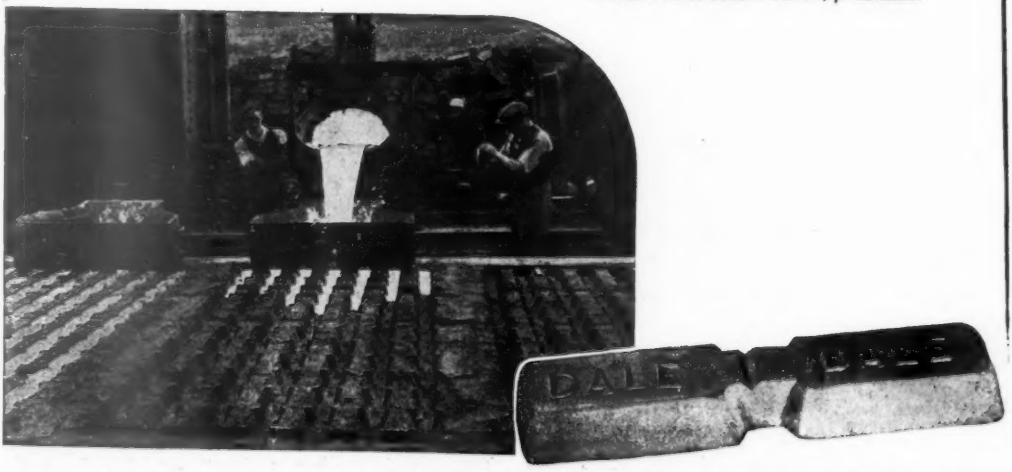
**IS CHARACTERISED** by closeness of grain structure, uniformity of composition and fine graphitic carbon evenly distributed.

**IS PRODUCED** to guaranteed analysis in seven standard grades.

**CAN BE MADE** to customers' individual requirements with total carbon from 2·6 per cent. upwards.

**SHOULD BE USED** to tone up high phosphorus irons and scrap, to replace Hematite, and to produce castings for all high duty purposes.

*Users are invited to avail themselves of the Stanton Technical Service which offers free expert advice on special mixtures and other Foundry problems.*




**THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM**

## COMPANY NEWS

*(Figures for previous year in brackets.)*

**Moss Gear**—Interim dividend of 7½% (same).

**Lake & Elliot**—Interim dividend of 5% (same).

**Frederick Braby & Company**—Interim dividend of 2½% (same).

**Hinchley Engineering Company,** 68, Victoria Street, London, S.W.1—£1,000. S. S. Coker.

**Metal Agencies**—Profit, £58,274 (£51,690); final dividend of 21½%, making 25% (20%).

**Ransomes & Rapier**—Final dividend of 4% on the ordinary shares, making 6% (5%), tax free.

**Craven Bros. (Manchester)**—Profit for 1942, £68,070 (£60,161); final dividend of 15% (10%), making 20% (14%).

**Enfield Rolling Mills**—Net profit for 1942, £24,062 (£12,062); dividend of 2½% (same); forward, £111,884 (£94,822).

**John Shaw & Sons Wolverhampton**—Net profit to June 30 last, £13,235 (£11,783); dividend of 7½% (same); forward, £13,679 (£11,593).

**Settle Limes**—No interim dividend. Directors state that there is little doubt of the company's ability to pay the usual 4 per cent., less tax, for the year.

**Vulcan Foundry**—Net profit for 1942, before tax, £143,447 (£156,178); tax, £118,479 (£125,000); ordinary dividend of 4% (3%); forward, £43,873 (£38,307).

**Laurence Scott & Electromotors**—Net profit for 1942, £108,202 (£95,856); dividend on the "A" and "B" ordinary shares of 12½%, or 7½d. per share (same).

**Boulton & Paul**—Net profit for the year to September 30, 1942, together with dividend from subsidiary, £94,771 (£136,639); tax, £60,000 (£95,000); additional depreciation, £2,233 (nil); to special contingencies reserve, £10,000 (nil); ordinary dividend of 5% (same); forward, £16,110 (£6,557).

**Birmingham Small Arms**—Trading profit for the year to July 31 last, £719,758 (£777,264); income-tax, £400,000 (£425,000); war damage contribution, £135,000 (£150,000); debenture service, £91,039 (£91,090); preference dividends, £15,596; ordinary dividend of 7½% (same); forward, £238,310 (£278,249).

**Cargo Fleet Iron**—Profit for the year to September 30 last, £202,626 (£170,743); interest on the 4% debenture stock, £38,452; staff pensions, etc., £6,489; sinking fund for 4% first mortgage debenture stock, £10,761; taxation, £70,000; war damage contributions, £9,364; depreciation, £65,000; forward, £98,569 (£97,771).

**Millom & Askam Hematite Iron**—Trading profit for 1942, £125,848 (£134,531); debenture interest and redemption, £11,557 (£11,440); taxation, £28,000 (£78,000); preference dividend, £27,362 (same); to reserve, £10,000 (nil); written off fixed assets, £20,000 (nil); ordinary dividend of 7½% (2½%), £21,932; forward, £41,755 (£39,829).

**A. Reyrolle**—Profit for 1942, after providing for depreciation, renewals and taxation, and including £125,908 (£105,708); to general reserve, £40,000 (£50,000); to development expenditure account, £35,000 (nil); dividend of 7% on the preference stock, £3,588 (same); final dividend of 7½% on the ordinary stock, making 12½% (same); forward, £139,197 (£145,421).

**South Durham Steel & Iron**—Profit for the year to September 30 last, £409,672 (£281,134); debenture interest, £43,180; staff pensions, etc., £3,653; dividend on the 6% cumulative preference shares, £18,000; sinking fund for 4% mortgage debenture stock, £7,820; taxation, £180,000 (£41,000); war damage contributions, £10,003; depreciation, £100,000 (same); dividend of 6% on the ordinary shares, £21,000 (same); additional dividend of 2½% on the ordinary shares, making 8½% (8%) for the year, £8,750; dividend of 2½% (2%) for the year on the "B" ordinary shares, £14,696; forward, £123,586 (£122,865).

## NEW COMPANIES

*("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)*

**Abrasive Tools,** 80-86, Regent Street, London, W.1—£1,000. G. Davies and F. W. Inns.

**Castings Reclamations,** 9, Aldermoor Road, Coventry—£1,000. C. Howkins and H. L. James.

**Frank Cuffe (Engineers),** Main Road, Woodmansey, East Yorks—£2,000. H. V. Marshall and F. Cuffe.

**Wm. Brand & Son (Bures)**—Agricultural engineers. £5,000. W. and H. E. Brand, Bures St. Mary, Suffolk.

**J. Grove & Son (Stampers & Piercers),** 47, Great Hampton Street, Birmingham—£2,500. E. K., R. J., and B. D. Grove.

**S. A. Baker (Engineers),** 102, Blackfriars Road, Salford—£10,000. S. A. and S. Baker, H. Ideson, and T. Keaveny.

**Erinex,** Flore, Northampton—Manufacturers of and dealers in bolts, nuts, screws, nails, etc. £1,000. M. M. Channell and F. G. Taylor.

**M.P.J. Gauge & Tool Company,** Hansons Bridge Road, Minworth, Birmingham—£10,000. A. E. McNamara, G. Powell, and W. Joyce.

**L. Savill,** 39, Cheapside, London, E.C.2—Manufacturers of and dealers in metal goods, tools, engineering products, etc. £1,000. L. H. Sayer.

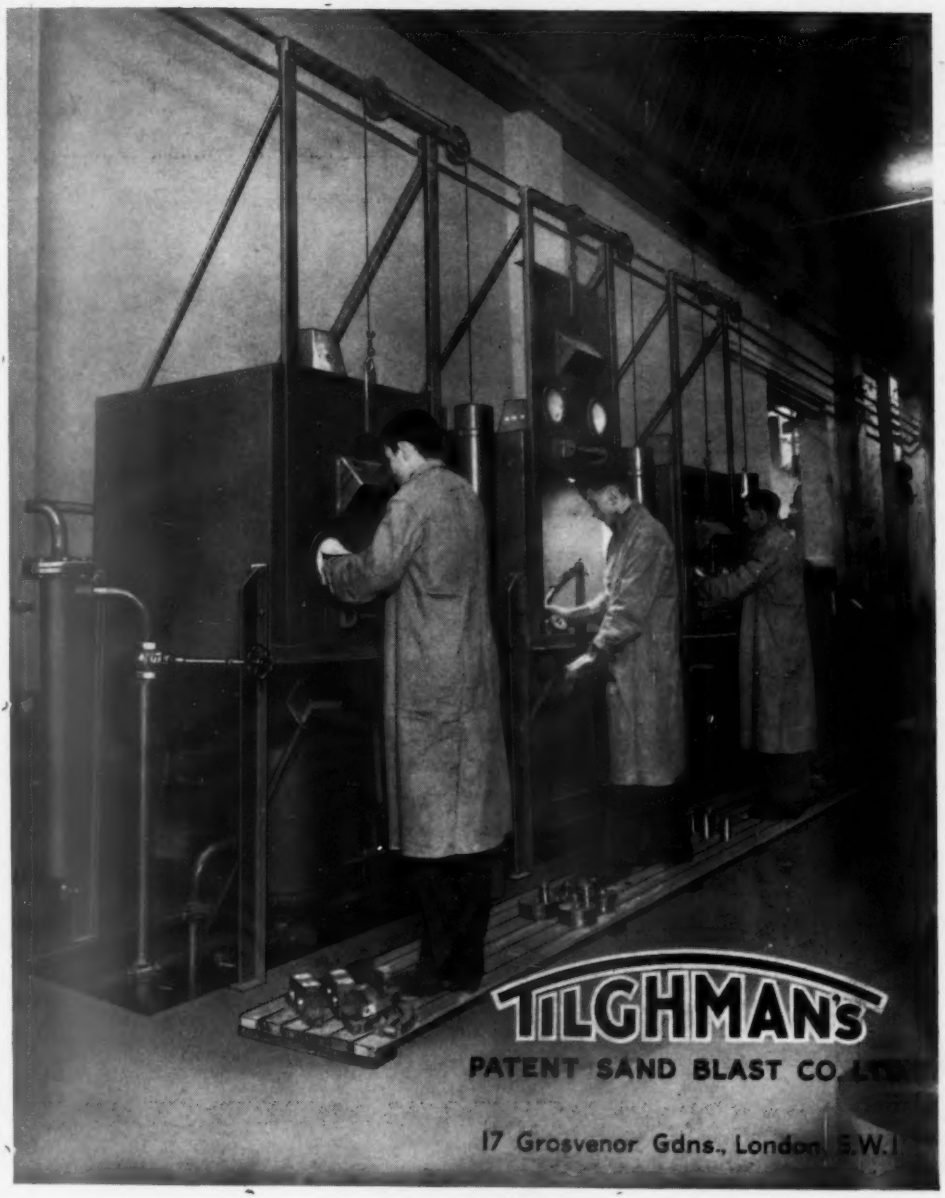
**Rowe & Potts,** 9, Ethelred Street, London, S.E.11—Iron, steel and metal merchants, engineers, etc. £12,000. G. F., M. M., and F. C. Rowe.

**M. Hales & Company,** 20, Whittall Street, Birmingham, 4—Manufacturers of and dealers in machinery, tools, etc. £4,000. E. V. and I. M. Hales.

**Reynolds & Bradwell,** 57, Colmore Row, Birmingham—Electrical engineers and contractors. £10,000. E. A. and D. E. Reynolds and G. Bradwell.

**Everwright (Leeds),** 54-56, Whitehall Road, Leeds—Tool makers, manufacturers of engineering equipment, etc. £1,000. H. S. Burrows and R. W. Waterhouse.

**William Hustler & Sons,** Henshaw Lane, Yeadon, Yorks—Mill furnishers, engineers, etc. £2,000. E. C. Bond, E. Bramald, W. A. Holmes, W. Swales and E. Walmsley.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